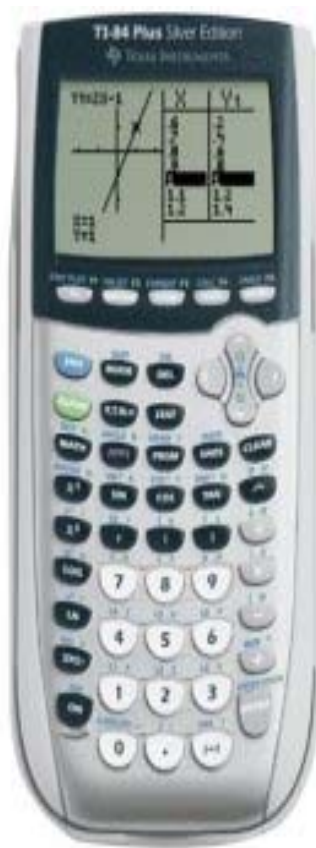


# TI-83+/TI-84+ In the Algebra I Classroom



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## Most Common Menu Screens

### CATALOG

Keystroke(s): **2ND**[0]

```

CATALOG
1:abs(
2:and
3:angle(
4:ANOVA(
5:Ans
6:Archive
7:Asm(
    
```

### MODE

Keystroke(s): **MODE**

```

Normal Sci Eng
Float 0123456789
Radian Degree
Func Par Pol Seq
Connected Dot
Sequential Simul
Real a+bi re^θi
Full Horiz G-T
    
```

### MATH

Keystroke(s): **MATH**

```

MATH NUM CPX PRB
1:Fract
2:Dec
3:
4:√(
5:×√
6:fMin(
7↓fMax(
    
```

### TEST

Keystroke(s): **2ND**[TEST]

```

TEST LOGIC
1:=
2:≠
3:>
4:≥
5:<
6:≤
    
```

### STAT

Keystroke(s): **STAT**

```

STAT CALC TESTS
1:Edit...
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor
    
```

### PROGRAMS

Keystroke(s): **PRGM**

```

PRGM EDIT NEW
    
```

### DRAW

Keystroke(s): **2ND**[DRAW]

```

DRAW POINTS STO
1:ClrDraw
2:Line(
3:Horizontal
4:Vertical
5:Tangent(
6:DrawF
7↓Shade(
    
```

### APPLICATIONS

Keystroke(s): **APPS**

```

APPLICATIONS
1:Finance...
2:CBL/CBR
3:LearnChk
4:Prob Sim
5:SciTools
6:StudyCrds
    
```

## Storing a Value for a Variable

## Finding an output:

This is helpful when students are asked to find an output, given an input. For example, let's find the value of  $\frac{(6x+9)}{x-3}$  when  $x = 2$ .

Action	Keystrokes
Turn the calculator ON	Press <b>ON</b>
Store solution for variable	Press <b>2</b> <b>STO →</b> <b>X,T,θ,n</b> <b>ENTER</b>
Enter expression	Press <b>(</b> <b>6</b> <b>X,T,θ,n</b> <b>+</b> <b>9</b> <b>)</b> <b>÷</b> <b>(</b> <b>X,T,θ,n</b> <b>-</b> <b>3</b> <b>)</b> <b>ENTER</b>
The answer will be displayed	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> 2→X  (6X+9)/(X-3)  -21 </div>

### Practice:

1. What is the value of  $x$  if  $y = 4$ ?  $x = -3y - 5$
2. What is the value of  $y$  if  $x = -8$ ?  $2x + y = 6x + 1$  (Hint: you should solve for  $y$  first)

### True/False Method:

This is extremely helpful when finding and checking solutions. Let's say we have to solve the equation  $2x + 1 = -5$ . The solution is  $x = -3$ .

Action	Keystrokes
Turn the calculator ON	Press <b>ON</b>
Store solution for variable	Press <b>(-)</b> <b>3</b> <b>STO →</b> <b>X,T,θ,n</b> <b>ENTER</b>
Enter entire equation	Press <b>2</b> <b>X,T,θ,n</b> <b>+</b> <b>1</b> <b>2ND</b> <b>MATH</b> <b>1</b> <b>(-)</b> <b>5</b> <b>ENTER</b>
If the screen displays a “1” the solution is correct. If the screen displays a “0”, the solution is incorrect.	<div> <div> <math display="block">-3 \neq X</math> <math display="block">2X+1=-5</math> </div> <div> <math display="block">-3</math> <math display="block">1</math> </div> </div>

❖ Note: If you use the equal sign (or inequality signs) on the Home Screen, only 0 or 1 will appear when you press **ENTER**. The “0” represents FALSE, and the “1” represents TRUE.

**“Storing” TAKS Practice:**

Sean is an Algebra I student who believes that  $xy^2 = (xy)^2$ . Rudy informs Sean that this theory is not always true. Which pair of values for  $x$  and  $y$  could Rudy use to disprove Sean's theory?

- F  $x = 0$  and  $y = 2$
- G  $x = 1$  and  $y = 2$
- H  $x = 2$  and  $y = 0$
- J  $x = 2$  and  $y = 1$

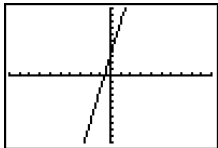
Which expression is equivalent to

$$\frac{2}{3}(3x - 15y) + (9y - 11x)?$$

- A  $-9x - y$
- B  $11x - 21y$
- C  $10x - 4y$
- D  $-9x - 26y$

## Graphing a Function

To demonstrate how to graph a function on the TI-83 or TI-83 Plus, let's use the following example. We will be graphing the equation  $y = 5x + 3$ .

Action	Keystrokes
Turn the calculator ON	Press <b>ON</b>
Go to Y= Screen	Press <b>Y=</b>
If you have equations entered, you will want to clear them first.	Move the cursor over each equation and press <b>CLEAR</b>
Place the cursor beside $Y_1=$	Use arrows if necessary
Enter equation	Press <b>5</b> <b>X,T,θ,n</b> <b>+</b> <b>3</b>
See graph	Press <b>GRAPH</b> 

### Default viewing window:

```

WINDOW
Xmin=-10
Xmax=10
Xscl=1
Ymin=-10
Ymax=10
Yscl=1
Xres=1

```

### Definition of terms:

**Xmin**—amount of negative x-axis that you see

**Xmax**—amount of positive x-axis that you see


**Xscl**—what the x-axis is counting by

**Ymin**—amount of negative y-axis that you see

**Ymax**—amount of positive y-axis that you see

**Yscl**—what the y-axis is counting by

**Xres**—don't worry about this one-leave it set at 1

Action	Keystrokes
Display viewing window	Press <b>WINDOW</b>
Change viewing window to show more positive y values	Move the cursor down to Ymax and type <b>2</b> <b>5</b>
See graph	Press <b>GRAPH</b>
Quick way back to default	Press <b>ZOOM</b> <b>6</b>
To change format of graph (turn grids on and off, turn axes on and off, etc.)	Press <b>2ND</b> <b>[FORMAT]</b> 

- ❖ Note: If you press **GRAPH** and get the message ERR:INVALID DIM, most likely one or more plots are turned on. Press **2ND****[STATPLOT]****4** to turn plots off, or press **Y=** and look to see if any PLOT on the top of this screen is highlighted. If it is, put your cursor over it and press **ENTER** to clear it.

## Drawing A Vertical Line

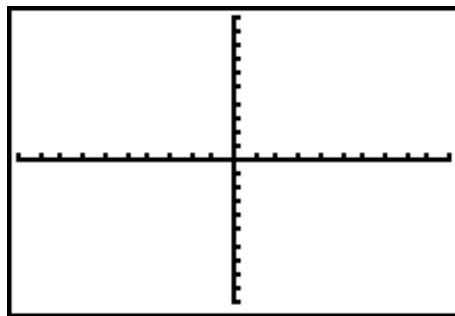
The TI 83 does not graph a vertical line such as  $x = 6$ , therefore a vertical line must be drawn using the DRAW function.

Action	Keystrokes
Clear Y=, or enter equation(s) that you want to see with your vertical line	
Open the DRAW menu from the Home Screen	Press <b>2ND</b> <b>[DRAW]</b>
Choose Option 4: Vertical	Press <b>4</b>
Enter the "x" value	Press <b>6</b> <b>ENTER</b> for $x = 6$
You will see the graph	

❖ Note: To clear the drawing, press **2ND****[DRAW]****1**

### **Practice:**

Graph and sketch  $y = x + 3$  and  $x = -2$  on the graph below.



# Graphing/Tracing/Table Activity

(Adapted from "Topics in Algebra 1: Linear Systems: Using Graphs & Tables", courtesy of TI)

You will:

- ❖ Graph two lines of a system of equations
- ❖ Use  $\square$  to locate the intersection of the lines
- ❖ Use [TABLE] and [TBLSET] to locate the exact solution of the system of equations

Find the solution of the system:  $y = -4x + 2$   
 $y = 2x - 2.5$

Notice that these equations are already in the form of  $y = mx + b$ . They are in the form to enter into your graphing calculator.

1. Enter  $y = -4x + 2$  as  $Y_1$  and  $y = 2x - 2.5$  as  $Y_2$  in  $Y=$ . Press  $\square$ . Clear any equations that may be on the screen by placing the cursor over the equation and pressing [CLEAR]. Use the  $\square$  key to enter "x" into the equations. **See Figure 1.**

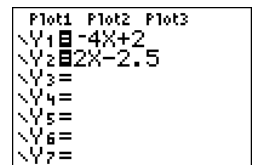


Figure 1

2. Set a "friendly window". Press [WINDOW] and enter the values as show in Figure 2.

- ❖ The viewing rectangle on the TI-83/84 is 94 pixels by 62 pixels (a pixel is a picture element). It is useful when graphing to have a "friendly window". A friendly window can be obtained by making the  $X_{min}$  and  $X_{max}$  multiples of 4.7 and the  $Y_{min}$  and  $Y_{max}$  multiples of 3.1, in order to avoid distortion in the graph and to avoid obtaining non-integer values when using the trace function of the TI-83/84.

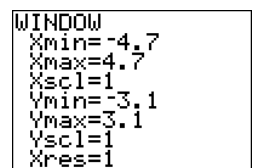


Figure 2

3. Press [TRACE] to graph the equations and have the ability to trace. Use the right and left arrow keys to move the cursor as close to the intersection of the two lines as possible. Since our "friendly window" traces by tenths, it is impossible to trace exactly on the intersection in this example, but we can get very close. **See Figure 3.**

- ❖ Note: The tracing cursor will be blinking on one of your functions when you press [TRACE]. To identify which line you are tracing, look at the top left corner of your screen. The equation of the line you are tracing will be displayed there.

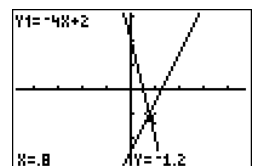


Figure 3

4. Use the table setup to refine the solution. Enter [TBLSET] by pressing  $\square$ [WINDOW]. Set up your table to show values close to  $X = .8$ . As shown in Figure 4, you can use a starting value of 0 with increments of 0.25.



Figure 4

5. Enter the table by pressing  $\square$ [GRAPH]. Use your down arrow key to scroll in the x column until you are near the value of .8. At  $x = .75$ , the y value of both lines is the same, meaning the intersection of the two lines is  $(.75, -1)$ . You also know that there is only one solution because the lines intersect at one point, so your search is complete.

**See Figure 5.**

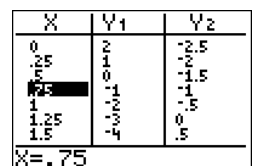


Figure 5

- ❖ Note: when you are viewing a table of more than one function, you can tell what function you are looking at by moving the cursor over to the y columns and up to highlight  $Y_1$ ,  $Y_2$ ,  $Y_3$ , etc. The equation of the function you are on will be displayed at the bottom of the screen.



## Solution Search

Solve the systems of equations and explain how you check the solutions using graphs and a table for each of the problems below. Do the following for each problem:

- ❖ Solve the system algebraically.
- ❖ Rewrite the system in slope-intercept form,  $y = mx + b$ , if necessary.
- ❖ Use the slope-intercept form of the equations to draw a rough sketch of the lines. You can verify your graph on your graphing calculator. Look at the solution you came up with and check to see if you have the correct number of solutions and that your solution(s) is located in the correct quadrant.
- ❖ Search for the solution of the equation on the graphing calculator using graphs and a table.  
Remember to change your viewing window (**WINDOW**) or your table setting (**2nd****WINDOW**) to do your search.
- ❖ Explain how you validated your solution on the graph or in the table.

**Remember:** The TI-73 and the TI-83/TI-84+ only use the variables X and Y for graphs and tables. If an equation uses letters other than X and Y, you have to change the variables in the problem to X and Y on the TI-73 and the TI-83/TI-84+. Use parentheses, if needed, when entering the equations in the Y= editor.

1.  $y = 2x + 4$   
 $3x + y = -11$

4.  $4x + 7y = 8$   
 $4x + 7y = 14$

2.  $-x + 3y = 4$   
 $\frac{1}{3}x + y = \frac{10}{3}$

5.  $x - 9y = 7$   
 $2x - 18y = 14$

3.  $2w + t = 35$   
 $\frac{-2}{5}w + \frac{1}{5}t = 19$

## Student Worksheet Answers:



### Solution Search

Tell students to:

- Rewrite the system in slope-intercept form,  $y = mx + b$ , if necessary.
- Use the slope-intercept form of the equations to draw a rough sketch of the lines. Verify the graphs on the graphing calculator.
- Search for the solution of the equation on the graphing calculator using graphs and a table.

**Notes:** Since the graphing calculator only uses the variables X and Y for graphs, tables and some other features, students must decide which variable in the problem should be X and which one should be Y when the problem uses other variables. Discuss independent and dependent variables, emphasizing that the graphing calculator is set up to treat X as the independent variable and Y as the dependent variable.

Remind students to use parentheses correctly when they enter equations into the Y= editor. For example,  $(1/3)X$  is not the same as  $1/3X$  which is  $1/(3X)$  when the order of operation rules are applied by the graphing calculator. However, when TI-73 users enter  $1/3$  using the  $\frac{\Box}{\Box}$  key, their entry is calculated correctly.

Remind students to change the viewing window ( **WINDOW** ) or table setting ( **2nd** **TBLSET** ) to do the search.  Tip™ 4: Creating a Table and  Tip 5: Adjusting the Viewing Window provide additional help with the graphing calculator.

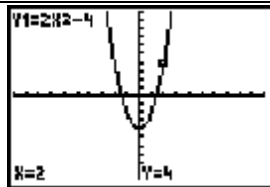
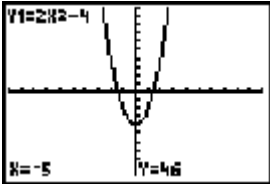
- Explain how they found the solution.

Answers:

1.  $(x, y) = (-3, -2)$
2.  $(x, y) = (3, 7/3)$
3.  $(w, t) = (-15, 65)$  Students are not given which variable is dependent and which is independent. They may very well write the solution as  $(t, w) = (65, -15)$ .
4. Lines are parallel, which implies that there are no solutions.
5. Lines are the same, which implies that there are an infinite number of solutions.

## Tracing for A Specific Coordinate

To demonstrate how to trace a function for a specific coordinate on the TI-83 or TI-83 Plus, let's use the following example. We will be graphing and tracing the equation  $y = 2x^2 - 4$ .

Action	Keystrokes	
Turn the calculator ON	Press <b>ON</b>	
Go to Y= Screen	Press <b>Y =</b>	
If you have equations entered, you will want to clear them first.	Move the cursor over each equation and press <b>CLEAR</b>	
Place the cursor beside $Y_1=$	Use arrows if necessary	
Enter equation	Press <b>2</b> <b>X,T,θ,n</b> <b>x<sup>2</sup></b> <b>-</b> <b>4</b>	
See graph	Press <b>GRAPH</b>	
View coordinates on graph	Press <b>TRACE</b>	
Trace x and y values	Use <i>right</i> and <i>left</i> arrow keys to trace the function	
Find the value of y when x is 2	Type <b>2</b> <b>ENTER</b>	
Find the value of y when x is -5	Type <b>(-)</b> <b>5</b> <b>ENTER</b>	

- ❖ Note: When you trace for a specific coordinate by typing in the “x” value, your window has to be set to include the “x” value that you are typing in. For example, if you type  $x = 20$ , your window must be set to at least an x-max of 20.

### Practice:

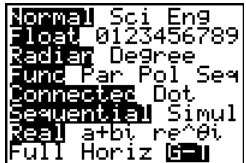
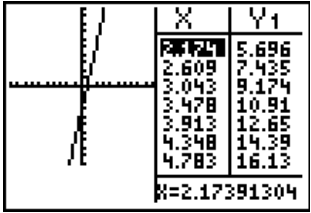
1. Graph  $y = 9x + 1$  in  $Y_1$ . What is the value of y when x is -7? \_\_\_\_\_

What is the value of y when x is 1.5? \_\_\_\_\_

2. Find the range of  $y = 2x + 4$  when the domain is  $\{-3, 0, 2\}$ . \_\_\_\_\_

## Tracing With G-T Split Screen

Let's look at the equation  $y = 4x - 3$

Action	Keystrokes
Change the Mode to G-T (Graph-Table)	Press <b>MODE</b> . Arrow key down and over to G-T. Press <b>ENTER</b> . 
Go to Y= screen	Press <b>Y=</b>
Enter equation	Press <b>4</b> <b>X,T,θ,n</b> <b>-</b> <b>3</b>
View Graph and Table	Press <b>GRAPH</b> 
Trace and view coordinates in the table	Press <b>TRACE</b> . Move cursor left and right.

# Working With Lists, StatPlot, and Regression

## Activity: Old MacDonald's Pigpen

(Adapted from Activity 2 in "EasyData Collection Activities", courtesy of Texas Instruments)



### Overview:

Old MacDonald has 40 meters of fencing to make a rectangular pen for his pigs. If he wants to give the little pigs as much room as possible, what should be the dimensions of the pen?

This is a simple maximum value problem that will allow students to use extra features on the calculator to check their calculations and save time.

### Data Collection:

1. Allow students to work in groups to fill in the chart on their worksheet. Then guide them in a discussion toward finding a general formula for calculating the length. Ask the students, "If 2 of the lengths plus 2 of the widths is forty, what would be the sum of one of the lengths plus one of the widths?" Lead the students from  $L + W = 20$  to the equation  $L = 20 - W$ .
2. Insert a new column and name it **WIDTH**, then enter the width of the rectangles into **WIDTH**. Have the students go into Stat Editor by pressing **[STAT]****[1]**. Use the up arrow key to highlight L<sub>1</sub>. Press **[2nd]****[DEL]** to insert a column. Type "WIDTH". Arrow key down to enter width values. **See Figures 1 & 2.**
3. Insert a new column and name it **LENGT** (for "LENGTH"—the calculator will only accept 5 characters). Rather than typing in all the lengths from their charts, show students how the calculator can do the work for them. Define **LENGT** with the formula for calculating the length arrived at in the discussion. Use the up arrow key and move the cursor to highlight **LENGT**. Type "**20 - WIDTH**". Press **[ALPHA]****[+]** to access the quotation marks and **[2nd]****[STAT]** to enter **WIDTH** into the equation. Press **[ENTER]** to see calculated values. **See Figures 3 & 4.**
4. Use the calculator to also find the perimeter and the area. Insert a new column and name it **PERI** (for "PERIMETER"). With the cursor highlighting **PERI**, type "**2WIDTH + 2LENGT**". Press **[ALPHA]****[+]** to access the quotation marks and **[2nd]****[STAT]** to access the list names **WIDTH** and **LENGT**. Press **[ENTER]** to see calculated values. **See figure 5.**

Because the perimeter is 40 for each pair of dimensions, this confirms that each triangle is using all 40 meters of fencing.

	L1	L2	1
	-----	-----	
Name=WIDTH			

Figure 1

WIDTH	L1	L2	1
4	-----	-----	
8			
11.25			
16			
6			
15.5			
9.5			
WIDTH(1)=4			

Figure 2

WIDTH		L1	2
4		-----	
8			
11.25			
16			
6			
15.5			
9.5			
Name=LENGT			

Figure 3

WIDTH		L1	2
4	16	-----	
8	12		
11.25	8.75		
16	4		
6	14		
15.5	4.5		
9.5	10.5		
LENGT="20-WIDTH"			

Figure 4

LENGT		L1	3
16	40	-----	
12	40		
8.75	40		
4	40		
14	40		
4.5	40		
10.5	40		
PERI="2*WIDTH+2*LENGT"			

Figure 5

5. Insert a new column and name it **AREA** (for “PERIMETER”). With the cursor highlighting **AREA**, type “**WIDTH\*LENGT**”. Press **[ALPHA][+]** to access the quotation marks and **[2nd][STAT]** to access the list names **WIDTH** and **LENGT**. Press **[ENTER]** to see calculated values. See figure 6.

LENGT #	PERI #	AREA # 4
16	40	64
12	40	96
8.75	40	98.438
2	40	36
14	40	84
4.5	40	69.75
10.5	40	99.75
AREA="WIDTH*LENGT"		

Figure 6

6. The **PERI** list does not need to be displayed from the next steps. Only three lists can be viewed at a time, and the lists **LENGT**, **WIDTH**, and **AREA** need to be in view. The order of the lists can be changed so that the lists that are needed will appear on the screen. To do this, put the cursor on **PERI** and press the **[DEL]** key. See figure 7.

WIDTH	LENGT #	AREA # 3
4	16	40
8	12	40
11.25	8.75	40
18	2	40
6	14	40
15.5	4.5	40
9.5	10.5	40
PERI="2*WIDTH+2*LENGT"		

Figure 7

7. This procedure will delete the list from view, but will not delete the list from memory or erase the values in the list. The three lists that are needed for the rest of the investigation can now be viewed on the calculator screen. See figure 8.

WIDTH	LENGT #	AREA # 3
4	16	64
8	12	96
11.25	8.75	98.438
18	2	36
6	14	84
15.5	4.5	69.75
9.5	10.5	99.75
AREA="WIDTH*LENGT"		

Figure 8

8. To more readily identify a pattern, it would be helpful to have the widths listed in order, from smallest to largest.
9. Let the calculator sort the list. Press the **[STAT]** key and select **2:SortA()** from the menu. This function will sort the list in ascending order. See figure 9.

```

2nd [STAT] CALC TESTS
1:Edit...
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor

```

Figure 9

10. This entry moves you to the Home Screen. Press and **[2nd][STAT]** to access the list name **WIDTH**, then press **[ENTER]** to execute the command. The calculator has now sorted the lists. See figure 10.

```

SortA(WIDTH)
Done

```

Figure 10

- ❖ NOTE: If **WIDTH** is entered, the calculator will arrange the numbers in the **WIDTH** list in order from least to greatest. This is where the importance of the quotation marks is demonstrated. Unless the other lists were built with quotation marks, the calculator will leave the numbers in those lists unsorted. This would result in the widths entered not matching up with the correct lengths, perimeters, or areas. Because the numbers in the other lists are related to the numbers in the first list, the entire row has to be carried along with the lead entry from **WIDTH** when it is sorted. Because **LENGT** and **AREA** were created with quotation marks, their entries will follow the entries in **WIDTH**. Also, when quotation marks are used in writing formulas, as variable values are changed, the calculator recalculates the ending value.

WIDTH	LENGT #	AREA # 1
2.25	17.75	39.938
4	16	64
6	14	84
8	12	96
9.5	10.5	99.75
11.25	8.75	98.438
WIDTH(1)=1		

Figure 11

11. To view the data press **[STAT][1]**. Notice that the data has been sorted and that **WIDTH** is listed in ascending order. Each width's corresponding length and area have remained in line with it. See Figure 11.

## Data Analysis:

- Now press  $\boxed{2\text{nd}}\boxed{Y=}$  to access [STAT PLOT]. Select **Option 1**. Highlight **On** and press  $\boxed{\text{ENTER}}$ . Select  $\boxed{\text{L1}}$  to create a scatter plot. Use **WIDTH** for Xlist and **AREA** for the Ylist (press  $\boxed{2\text{nd}}\boxed{\text{STAT}}$  to access the list names). These entries will allow the area to be graphed as a function of the width of the rectangles. This is a good time to review vocabulary such as “Y is a function of X” which leads to “the area is a function of the widths”. Help students identify the width as the independent variable and the area as the dependent variable. **See Figure 12.**



Figure 12

- Press  $\boxed{\text{ZOOM}}\boxed{9}$  to graph using Zoom Stat. The points plotted should be in view. Press  $\boxed{\text{TRACE}}$  and scroll right and left to see the X- and Y-values of the data points. Ask students to name the shape of the graph if the points were connected. **See Figure 13.**

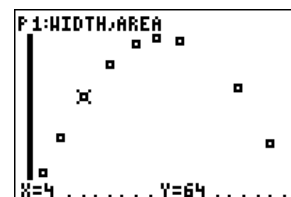


Figure 13

- Lead students to realize it looks like a parabola and tell them that the calculator can find the equation of the parabola for them. Find the regression equation and paste it into  $Y_1$ . Press  $\boxed{\text{STAT}}$  and scroll over to **CALC**. Choose **Option 5:QuadReg**. **See Figure 14.**

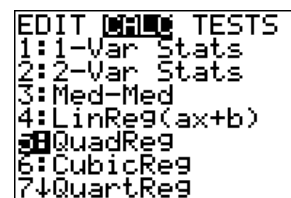


Figure 14

- When **QuadReg** appears on the Home Screen, use  $\boxed{2\text{nd}}\boxed{\text{STAT}}$  to select **WIDTH**. Insert a comma by typing  $\boxed{,}$ . Press  $\boxed{2\text{nd}}\boxed{\text{STAT}}$  to select **AREA**. Type  $\boxed{,}$ . To tell the calculator to put the equation into  $Y_1$ , press  $\boxed{\text{VARS}}$ , then scroll over to **Y-VARS**. Choose **Option 1:Function**. Choose **Option 1:  $Y_1$** . Press  $\boxed{\text{ENTER}}$ . **See Figures 15 - 19.**

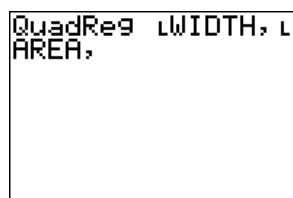


Figure 15

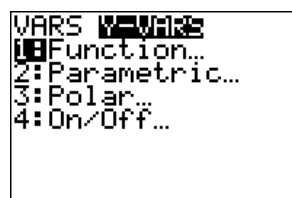


Figure 16

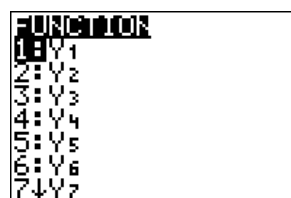


Figure 17

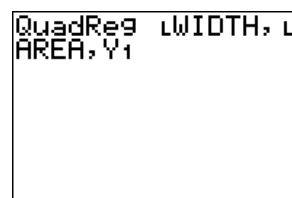


Figure 18

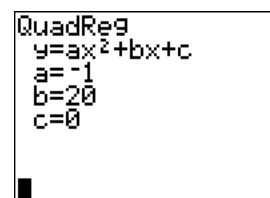


Figure 19

- Go to the  $\boxed{Y=}$  window. Notice that the coefficients are very long decimal numbers. Although the **a**-value on the home screen was -1 and the **b**-value was 20, here the **a**- and **b**-values have rounding errors. This is a great time for a discussion about the fact that the calculator is a tool and it is only as good as the person using it. Students need to recognize that -.99999999 is equivalent to -1 and 19.99999999 is equivalent to 20 (as far as the calculator goes!). **See Figure 20.**

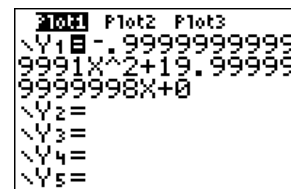


Figure 20

- Press  $\boxed{\text{GRAPH}}$  and watch the calculator connect the points that were already plotted. Examine how closely the regression equation fits the points. **See Figure 21.**

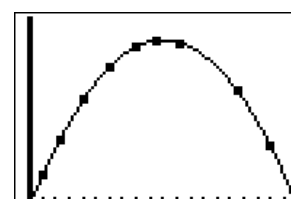


Figure 21

7. Next, find the maximum area of the pigpen. Press **2nd****TRACE** to access the **[CALC]** menu and choose Option **4:maximum**. See Figure 22.

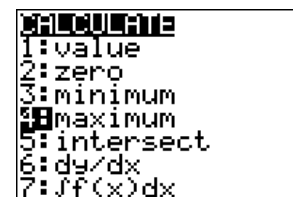


Figure 22

8. Press **ENTER**. This takes you back to the graph. Follow the onscreen instructions to identify the maximum area. When asked for the **Left Bound**, move the left arrow key until the cursor is clearly to the left of the vertex and press **ENTER**. That choice is marked and the onscreen question changes.
9. When asked for the **Right Bound**, move the right arrow key until the cursor is clearly to the right of the vertex and press **ENTER**. Again, the choice is marked and the onscreen question changes.
10. When asked for a **Guess**, move the cursor close to the vertex point and press **ENTER**. See Figures 23 - 25.

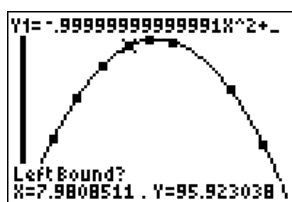


Figure 23

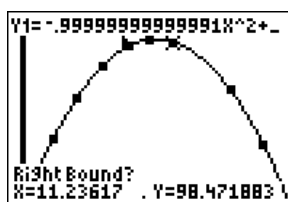


Figure 24

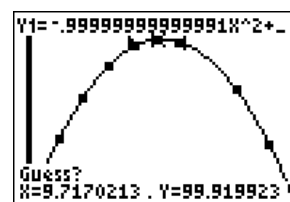


Figure 25

11. The maximum point of the graph is displayed. Since the **x**-term corresponds to the width, 10 meters is the maximum width needed to form the rectangle that contains the maximum area. The **y**-term corresponds to the area, so  $100 \text{ m}^2$  is the maximum area of the rectangular pigpen. See Figure 26.

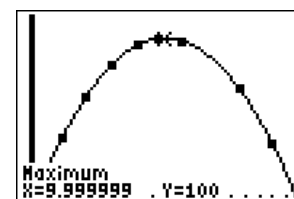


Figure 26

### Discussion Notes:

Guide your students in a discussion that will lead them to an understanding of the variables in this problem. You should be able to count on students at this level knowing that a rectangle's Area = length x width. Help them see that this problem can be simple.

Substituting  $x$  for width and  $20 - x$  for length, show them that the Area =  $(20 - x)x$  or  $A(x) = 20x - x^2$ . In standard form, the equation becomes  $-x^2 + 20x$ . Match this equation to the standard quadratic equation  $y = ax^2 + bx + c$ , with  $a = -1$ ,  $b = 20$ , and  $c = 0$  as the coefficients. These are precise constants and are not rounded. They help to conclude that those long decimal numbers on the **[Y=]** screen were the result of rounding errors.

Pre-Algebra students will need to depend on the calculator to identify the maximum values, but Algebra students who have studied quadratics can identify the **x**-value of the vertex as being found at  $-b/2a$ . For the values in this problem, the vertex would be  $-20/(2 \cdot -1) = 10$ . This is the width of the rectangle with the largest area. The maximum area would be  $10(20 - 10) = 100$ . The worksheet that accompanies this activity is designed to help lead students through this reasoning.



## Worksheet Answers

Rect #	Width	Length	Per	Area
1.	4 m	16	40	64
2.	8 m	12	40	96
3.	$11\frac{1}{4}$ m	8.75	40	98.438
4.	18 m	2	40	36
5.	6 m	14	40	84
6.	$15\frac{1}{2}$ m	4.5	40	69.75
7.	$9\frac{1}{2}$ m	10.5	40-	99.75
8.	$2\frac{1}{4}$ m	17.75	40	39.983
9.	1m	19	40	19
10.	$x$	$20 - x$	40	$x(20 - x)$

11.  $A(x) = x(20 - x)$

12. quadratic, parabola

13. vertex

14. width

15. area

16. width

17. maximum area

# Old MacDonald's Pigpen




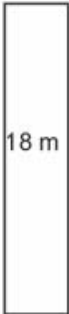

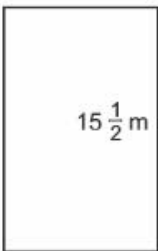



## Math Objectives:

- Graph scatter plots
- Graph and analyze quadratic functions
- Calculate the maximum value of a parabola

## Materials:

- TI-83/TI-84 Plus Family

Old MacDonald has 40 meters of fencing to make a rectangular pen for his pigs. If he wants to give the little pigs as much room as possible, what should be the dimensions of the pen? He started to figure this out by drawing a few sample rectangles below. Mark the sides of the following rectangles with the lengths that would ensure that each rectangle has a perimeter of 40 meters. Fill in the chart on the next page. Make sure the perimeter is always 40 meters. Find the area of each rectangle.

-  4 m
-  8 m
-   $11\frac{1}{4}$  m
-  18 m
-  6 m
-   $15\frac{1}{2}$  m
-   $9\frac{1}{2}$  m
-   $2\frac{1}{4}$  m
-  1 m

10.

Rectangle #	Width	Length	Perimeter	Area
1.	4 m			
2.	8 m			
3.	$11\frac{1}{4}$ m			
4.	18 m			
5.	6 m			
6.	$15\frac{1}{2}$ m			
7.	$9\frac{1}{2}$ m			
8.	$2\frac{1}{4}$ m			
9.	1m			
10.	x			

11. The chart makes it plain that the area of the rectangles is a function of the length of the sides. Use **X** to denote the width and write an equation that relates the area to **X**. This is no more difficult than saying Area = length x width.  $A(x) =$ \_\_\_\_\_.
12. This is a \_\_\_\_\_ equation. Its graph will be a \_\_\_\_\_.
13. To find the maximum area, find the \_\_\_\_\_ of the graph.
14. The **X**-value stands for the \_\_\_\_\_ of the rectangles.
15. The **Y**-value stands for the \_\_\_\_\_ of the rectangles.
16. The **X**-value of the vertex tells us the \_\_\_\_\_ of the rectangle with the maximum area.
17. The **Y**-value of the vertex tells us the value of the \_\_\_\_\_.

## Texas Instruments

Content Unit Report – showing Matching Standards as of 7/21/2008

Grade: 9

States: TX

### Old MacDonald's Pigpen

Summary: In this activity, students solve a standard maximum value problem using the calculator. Students help Old MacDonald build a rectangular pigpen with 40 m fencing that provides maximum area for the pigs. They graph scatter plots, analyze quadratic functions, and find maximum value of a parabola. Products: TI-83 Plus Family, TI-84 Plus Family, TI Connect(TM)

## State: Texas TEKS Standards

Grade: 9

Subject: Mathematics

TEKS	TX.111.32 (9.B2.)	Algebra I: Foundations for Functions: The student uses the properties and attributes of functions.
STUDENT EXPECTATION	9.B2 (D)	In solving problems, the student collects and organizes data, makes and interprets scatter plots, and models, predicts, and makes decisions and critical judgments.
TEKS	TX.111.32 (9.D1.)	Algebra I: Quadratic and Other Nonlinear Functions: The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions.
STUDENT EXPECTATION	9.D1 (D)	For problem situations, the student analyzes graphs of quadratic functions and draws conclusions.
TEKS	TX.111.32 (9.D2.)	Algebra I: Quadratic and Other Nonlinear Functions: The student understands there is more than one way to solve a quadratic equation and solves them using appropriate methods.
STUDENT EXPECTATION	9.D2 (B)	The student relates the solutions of quadratic equations to the roots of their functions.
TEKS	TX.111.33 (9.B1.)	Algebra II: Foundations for Functions: The student uses properties and attributes of functions and applies functions to problem situations.
STUDENT EXPECTATION	9.B1 (B)	In solving problems, the student collects data and records results, organizes the data, makes scatter plots, fits the curves to the appropriate parent function, interprets the results, and proceeds to model, predict, and make decisions and critical judgments.
TEKS	TX.111.33 (9.D1.)	Algebra II: Quadratic and Square Root Functions: The student understands that quadratic functions can be represented in different ways and translates among their various representations.
STUDENT EXPECTATION	9.D1 (B)	The student relates representations of quadratic functions, such as algebraic, tabular, graphical, and verbal descriptions.

TEKS	TX.111.33 (9.D3.)	Algebra II: Quadratic and Square Root Functions: The student formulates equations and inequalities based on quadratic functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.
STUDENT EXPECTATION	9.D3 (C)	The student compares and translates between algebraic and graphical solutions of quadratic equations.
TEKS	TX.111.35 (9.C1.)	Precalculus: The student defines functions, describes characteristics of functions, and translates among verbal, numerical, graphical, and symbolic representations of functions, including polynomial, rational, radical, exponential, logarithmic, trigonometric, and piecewise-defined functions.
STUDENT EXPECTATION	9.C1 (D)	The student is expected to recognize and use connections among significant points of a function (roots, maximum points, and minimum points), the graph of a function, and the symbolic representation of a function.
TEKS	TX.111.35 (9.C3.)	Precalculus: The student uses functions and their properties to model and solve real-life problems.
STUDENT EXPECTATION	9.C3 (B)	The student is expected to use regression to determine a function to model real-life data.
TEKS	TX.111.36 (9.C2.)	Mathematical Models with Applications: The student uses graphical and numerical techniques to study patterns and analyze data.
STUDENT EXPECTATION	9.C2 (A)	The student is expected to interpret information from various graphs, including line graphs, bar graphs, circle graphs, histograms, and scatter plots to draw conclusions from the data.
STUDENT EXPECTATION	9.C2 (D)	The student is expected to use regression methods available through technology to describe various models for data such as linear, quadratic, exponential, etc., select the most appropriate model, and use the model to interpret information.
TEKS	TX.111.36 (9.C3.)	Mathematical Models with Applications: The student develops and implements a plan for collecting and analyzing data in order to make decisions.
STUDENT EXPECTATION	9.C3 (A)	The student is expected to formulate a meaningful question, determine the data needed to answer the question, gather the appropriate data, analyze the data, and draw reasonable conclusions.

## Texas Instruments

Content Unit Report – showing Matching Standards as of 7/21/2008

Grades: 9

States: TX

### Old MacDonald's Pigpen

Summary: In this activity, students solve a standard maximum value problem using the calculator. Students help Old MacDonald build a rectangular pigpen with 40 m fencing that provides maximum area for the pigs. They graph scatter plots, analyze quadratic functions, and find maximum value of a parabola. Products: TI-83 Plus Family, TI-84 Plus Family, TI Connect(TM)

**State:** Texas TAKS Standards

**Grade:** 9

**Subject:** Mathematics

<b>TAKS OBJECTIVE</b>	TX.2.	Mathematics TAKS Objective 2: The student will demonstrate an understanding of the properties and attributes of functions. (2006 TAKS: 5 Items)
<b>STUDENT EXPECTATION</b>	A(b)(2)	Foundations for functions. The student uses the properties and attributes of functions.
<b>GRADE LEVEL EXPECTATION</b>	A(b)(2). (D)	In solving problems, the student [collects and] organizes data, [makes and] interprets scatterplots, and models, predicts, and makes decisions and critical judgments. (2006 TAKS)

## Stat Editor Extras

### Clearing lists one at a time

Action	Keystrokes
Enter Stat Editor	Press <b>STAT</b>
Select Edit	Press <b>1</b>
Highlight the list to clear	Use the <i>right</i> , <i>left</i> and <i>up</i> arrow keys to highlight the list you wish to clear
Clear the list	Press <b>CLEAR</b> then press the <i>down</i> arrow key

### Clearing selected lists all at once

Action	Keystrokes
Enter Stat Editor	Press <b>STAT</b>
Select ClrLists prompt	Press <b>4</b> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-top: 5px;"> <b>EDIT</b> CALC TESTS            1:Edit...            2:SortA&lt;            3:SortD&lt;            4:ClrList            5:SetUpEditor         </div>
List your lists with commas in between	Type <b>2ND</b> [ <b>L<sub>1</sub></b> ], <b>2ND</b> [ <b>L<sub>2</sub></b> ]
Finalize	Press <b>ENTER</b>
Screen should say DONE	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-top: 5px;">           ClrList L1,L2            Done         </div>

### Practice:

In  $L_1$ , type 5, 2, 4. In  $L_2$ , type 15, 3, 9, 6. In  $L_3$ , type 7, 8, 1. Clear only lists 1 and 3 using the instructions above. Return to Stat Editor to view List 2.


### Clearing all lists at once

Action	Keystrokes
Enter MEMORY menu	Press <b>2ND</b> [ <b>MEM</b> ]
Select 4: ClrAllLists prompt	Press <b>4</b> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-top: 5px;"> <b>MEMORY</b>            1&gt;About            2:Mem Mgmt/Del...            3:Clear Entries            4:ClrAllLists            5:Archive            6:UnArchive            7:Reset...         </div>
Finalize	Press <b>ENTER</b>
Screen should say DONE	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-top: 5px;">           ClrAllLists            Done         </div>


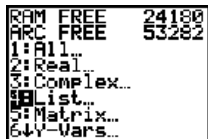
**Practice:**

In L<sub>1</sub>, type 6, 7, 3. In L<sub>2</sub>, type 15, 4, 9, 7. In L<sub>3</sub>, type 7, 5, 1. Clear all lists by using the instructions above. Return to Stat Editor to see that all lists are clear.

## Turning off all plots at once

Action	Keystrokes
Enter stat plot editor	Press <b>2ND</b> <b>[STATPLOT]</b>
Select PlotsOff	Press <b>4</b> 
Finalize	Press <b>ENTER</b>
Screen should say DONE	

## Deleting a list

Action	Keystrokes
Enter Memory Editor	Press <b>2ND</b> <b>[MEM]</b>
Select Mem Mgmt/Delete	Press <b>2</b> 
Select List	Press <b>4</b> 
Select the list to delete	Use <i>up</i> and <i>down</i> arrow keys and the <b>ENTER</b> key to select list(s) to delete (* will be displayed beside all selected lists)
Delete the list(s)	Press <b>DELETE</b>
You will be asked if you are sure	Press <b>1</b> for No or <b>2</b> for Yes

- ❖ **Note:** To reset the calculator so that only lists **L1** through **L6** are displayed, Press **STAT** and select **5:SetUpEditor** (This will not delete any lists)



## Great Calculator Websites

Texas Instruments [www.education.ti.com](http://www.education.ti.com)

Region IV Education Service Center Calculator Help <http://www.escweb.net/math/>

TI-83 Plus Tutorial

<http://www.acc.scsu.ctstateu.edu/miscellanea/ti83demo/ti83/index.html>

Texas Instruments Calculator Tutorials

[http://education.ti.com/educationportal/sites/US/nonProductMulti/training\\_online\\_tutorials.html?bid=4](http://education.ti.com/educationportal/sites/US/nonProductMulti/training_online_tutorials.html?bid=4)

Answers to Frequently Asked Questions

<http://www.prenhall.com/divisions/esm/app/graphing/ti83/faq/faq.html>

Ohlone College Calculator Help <http://www2.ohlone.edu/people2/joconnell/ti/>

Hotmath Calculator Help [http://hotmath.com/graphing\\_calculators/](http://hotmath.com/graphing_calculators/)

TI 83/84 Plus Basic Math Programs (Downloads)

<http://www.ticalc.org/pub/83plus/basic/math/>

Links to Online Calculators <http://ocmpf.fullerton.edu/graphingcalculators.htm>